ATEKO a.s.

1949 – 2020

S-ALLEGRO Experimental Helium Loop

S-ALLEGRO Experimental Helium Loop

Reason For A New Technology Research:

The aim of the S-ALLEGRO experimental program is to model the basic safety characteristics of a high-temperature, fast-cooled helium-cooled reactor (GFR) or its demonstration unit ALLEGRO

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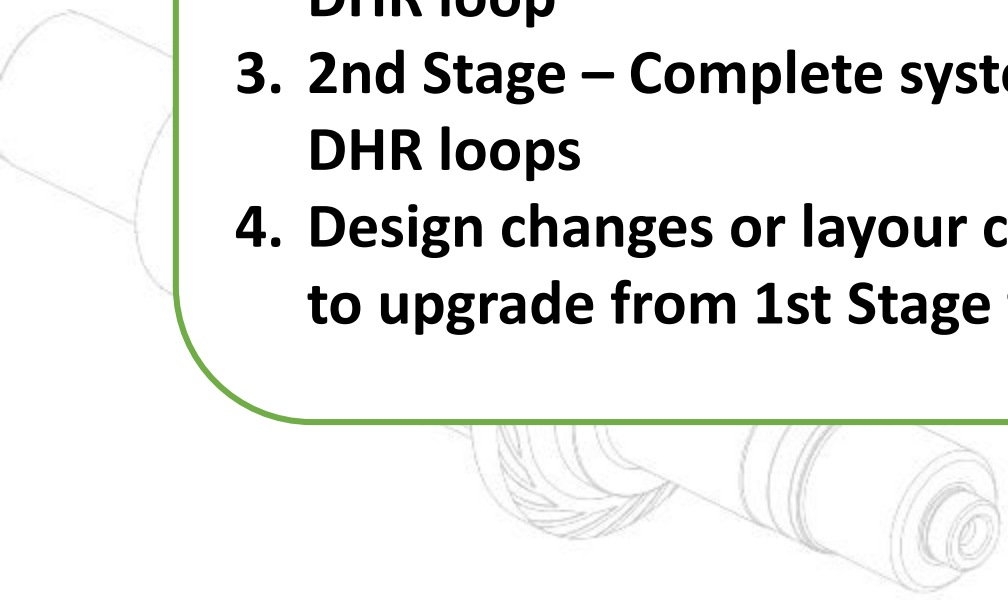
General Design Features:

1. Modular layout
2. 1st Stage – Functional specimen, 1 primary loop, 1 DHR loop
3. 2nd Stage – Complete system, 2 primary loops, 3 DHR loops
4. Design changes or layour changes are not required to upgrade from 1st Stage to 2nd Stage



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ALLEGRO Reactor Characteristics To Be Verified:

- **Residual heat removal system**
- **Natural circulation cooling**
- **Systemic behavior in transition states**
- **System behavior under emergency conditions**
- **Overall system performance in terms of heat loss, temperature fields and the effect of parameter changes on the entire system**

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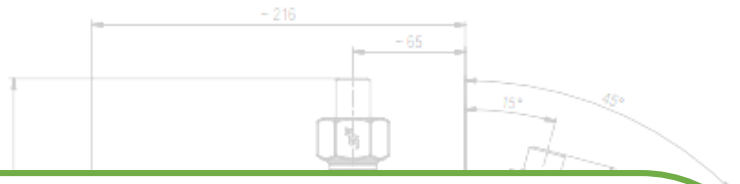
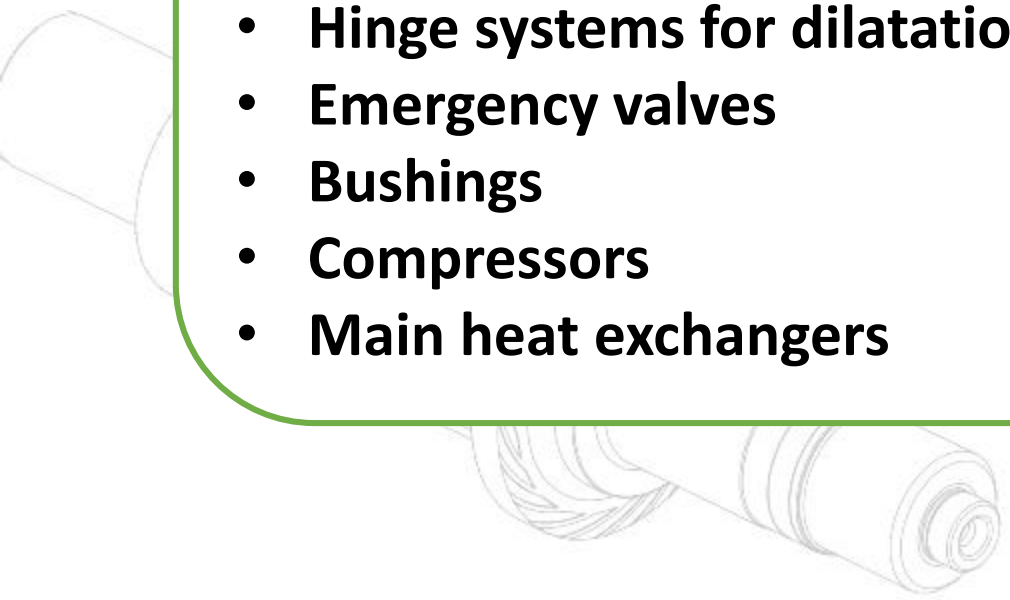


Other Elements To Be Modeled:

- Design materials
- Manufacturing technology
- Sealing systems
- Hinge systems for dilatation solutions
- Emergency valves
- Bushings
- Compressors
- Main heat exchangers



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Pipeline Design Feature:

- **The main (primary) and DHR branch piping is designed as coaxial one**
- **Helium of higher temperature flows in the inner pipe**
- **Coaxial piping on the main (primary) branch is equipped with a HV100 shut-off valve, which closes both sides of the coaxial pipeline under specific conditions in the loop or at the operator's command**

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Pipeline Design Feature (continued):

- On the DHR branch, the coaxial piping is equipped with a HV500 cross valve, which is not completely tight in the "closed" state, but allows the flow to cross and thus low DHR flow through the branches in the correct direction
- This function keeps the pipeline in a “warm” state ready for immediate use of the DHR branch
- In the next stage, the DHR branch will be further equipped with a circulating compressor
- Experiments with this branch in the forced circulation mode enabled

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Helium Heat Transfer:

- **Helium in the DHR branch is cooled in DHR exchanger W201 with water**
- **In the main branch (primary circuit) there is a countercurrent exchanger-primary exchanger W103, where the primary helium transfers heat to the secondary circuit, where helium is also used as working medium**
- **The helium in the secondary circuit is then cooled in the water cooler - secondary exchanger W102 equipped with a circulating compressor**

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Further Loop Features:

- **The S-ALLEGRO loop is also equipped with, among other things, cooling gas injection inputs or an organized leakage system to simulate the LOCA accident**
- **The S-ALLEGRO loop allows for a wide range of experiments to simulate both the stationary state of the Allegro reactor demonstration unit and various transition states.**
- **Experimental possibilities are limited only by the safety limits of the device, (final size of pressure and temperature gradients, maximum value of temperature and pressure)**

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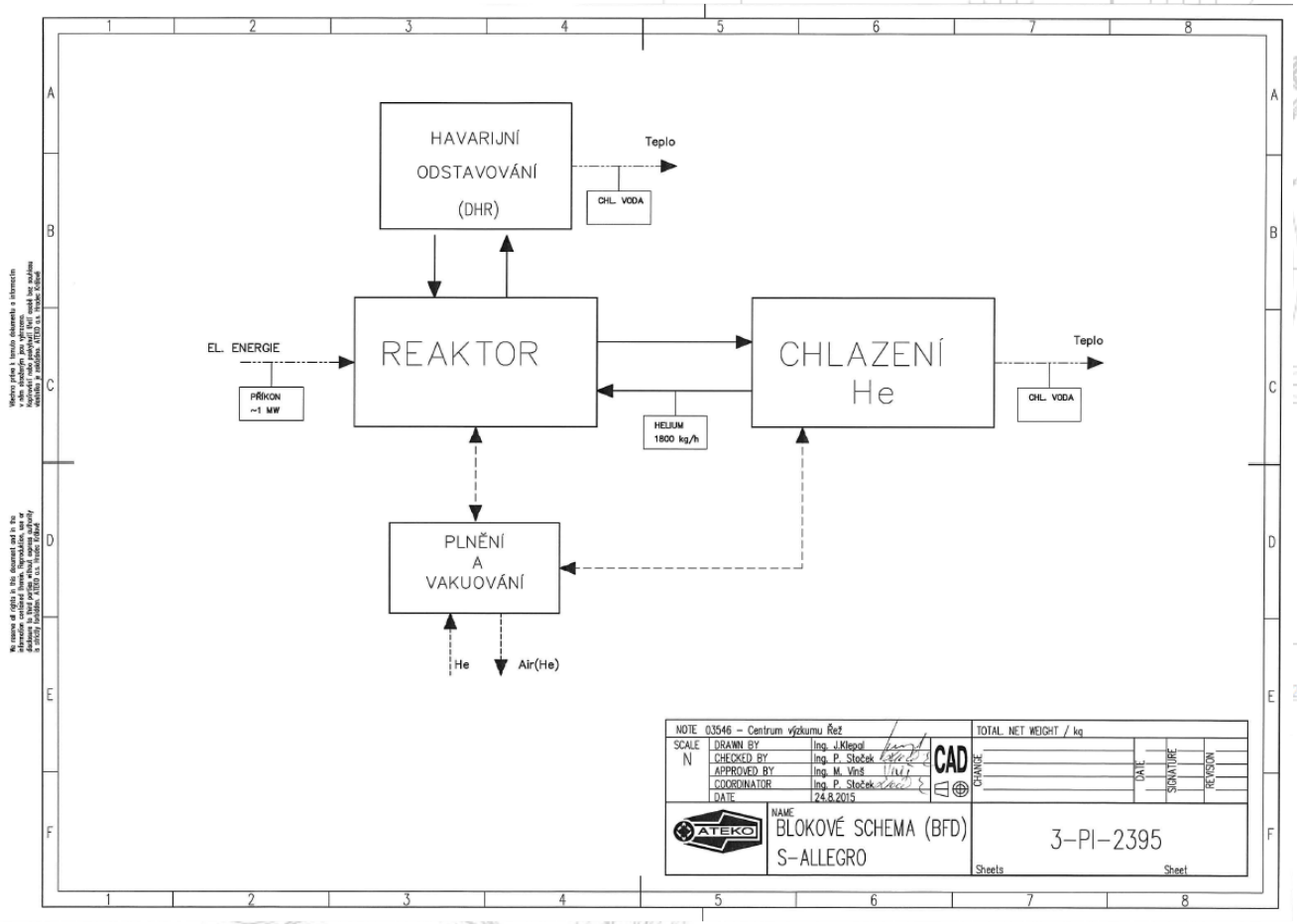
S-ALLEGRO BFD



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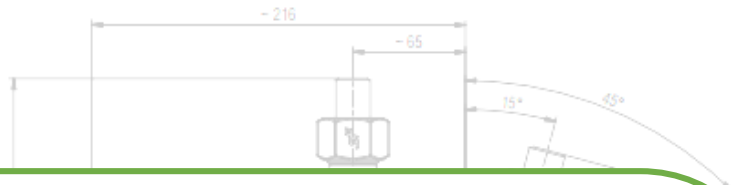
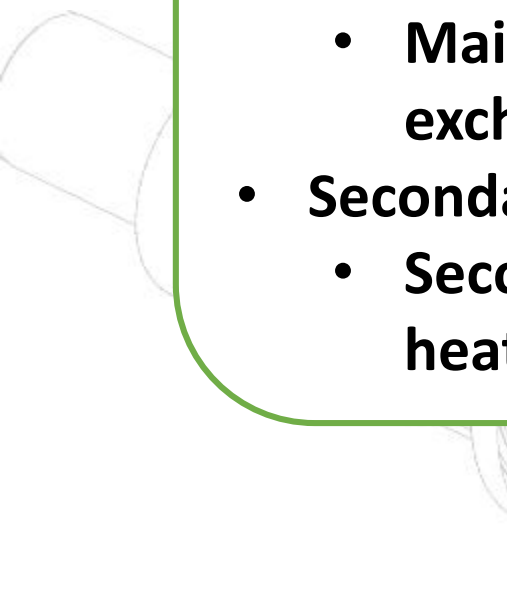


S-ALLEGRO Technology:

- **Primary circuit:**
  - **Primary helium loop with R101 reactor vessel and TC101 turbocirculator**
  - **Main heat exchanger - W103 primary heat exchanger**
- **Secondary circuit:**
  - **Secondary helium loop with W102 secondary heat exchanger and TC102 turbocirculator**



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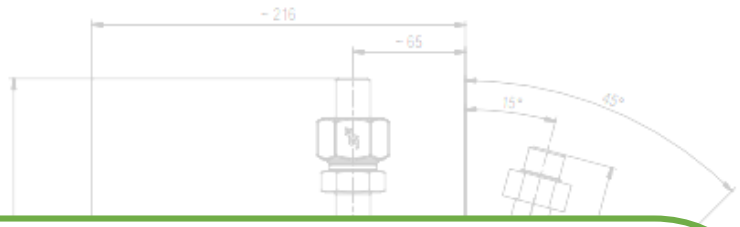
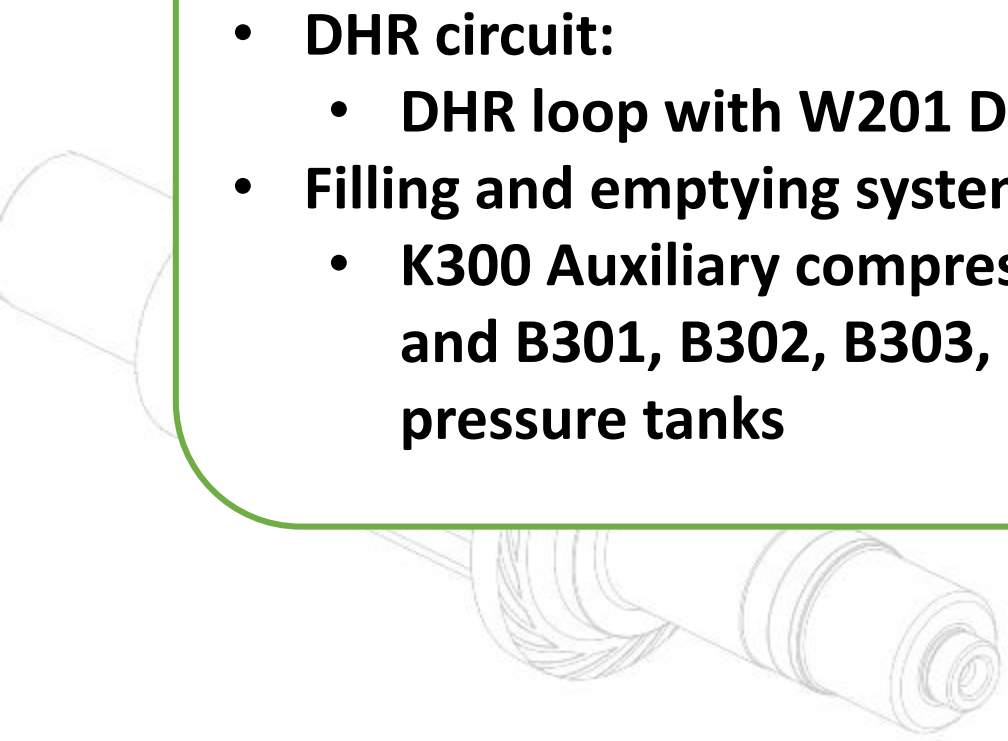


S-ALLEGRO Technology (continued):

- **DHR circuit:**
  - **DHR loop with W201 DHR heat exchanger**
- **Filling and emptying system:**
  - **K300 Auxiliary compressor with B300 air tank and B301, B302, B303, B304 and B305 storage pressure tanks**



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S-ALLEGRO Operating Parameters:

- **Primary Helium flow: 1800 kgs / hour**
- **Electric heating heat input: 1 MWPrimary**
- **Pressure areas:**
  - **Primary area 1: 75 bar(g), 550 °C**
  - **Primary area 1 inner parts: 1 bar(g), 850 °C**
  - **Primary area 2: 75 bar(g), 850 °C**
  - **Secondary area: 70 bar(g), 550 °C**
  - **Secondary area inner parts: 1 bar(g), 850 °C**
  - **Secondary area 2: 70 bar(g), 850 °C**
  - **Pressure bottles: 230 bar(g), 100 °C**
  - **Water circuit: 10 bar(g), 100 °C**
- **Tightness: 0,1% of total system volume per 24 hours**

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S-ALLEGRO Operating Modes:

Normal operations (Automatic control system maintains nominal regime according to concrete experiment):

1. Preparation and filling of the loop to the prescribed pressure,
2. Temperature increase with prescribed gradient of 50 ° C / hour, endurance at several defined temperature levels (200 °C, 400 °C, 600 °C) until steady state is reached,
3. At the required maximum temperature, pressurizing the system to the required pressure;
4. Stability to achieve steady state;
5. Shutdown of equipment with prescribed temperature gradient.

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S-ALLEGRO Operating Modes (continued):

Abnormal operations (Predefined situation, failure of one of the loop elements):

1. LOFA (Loss Of Flow Accident)
2. Cooling systém failure
3. SBO (Station Blackout)
4. Control system failure
5. Transition from forced DHR circuit to natural circulation
6. LOCA (Loss of coolant accident)
7. DHR valve failure and faulty opening during nominal operation
8. Secondary circuit cooling loss

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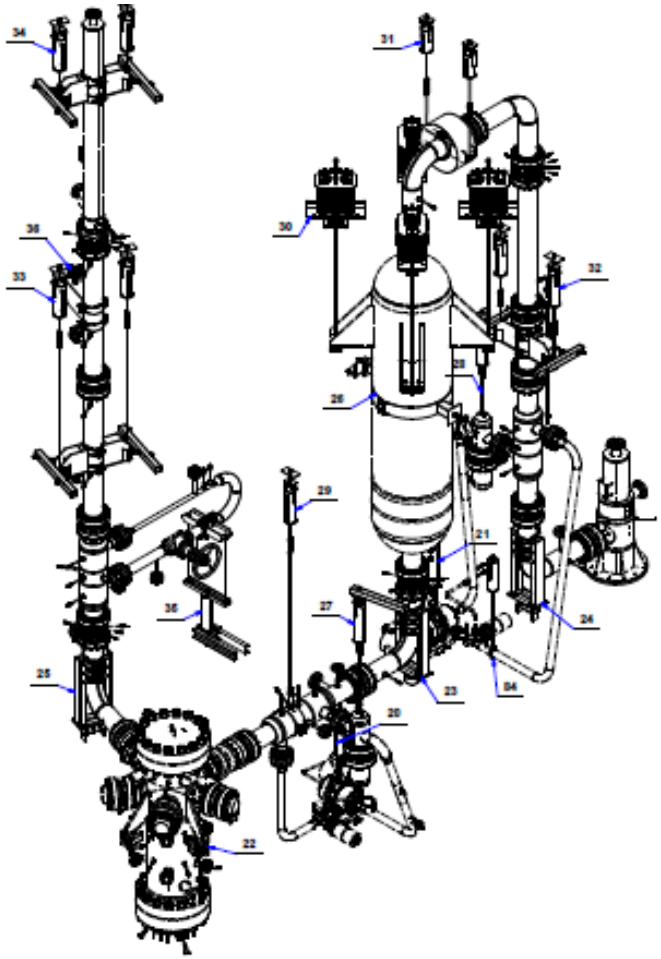
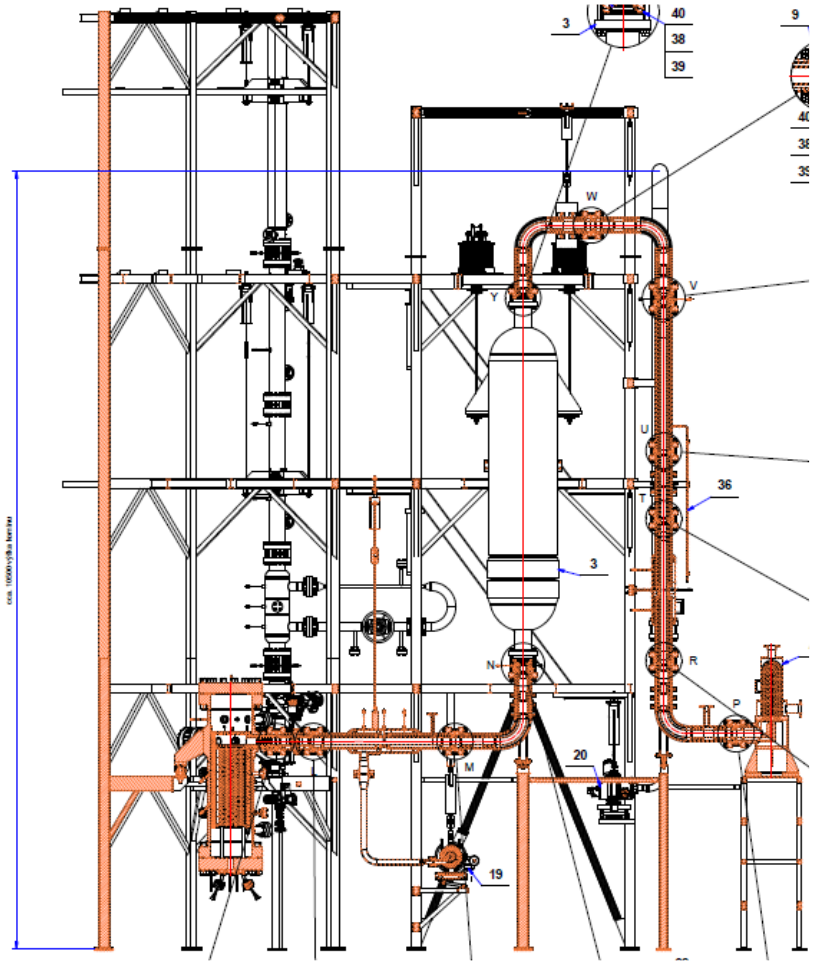
S-ALLEGRO Assembly

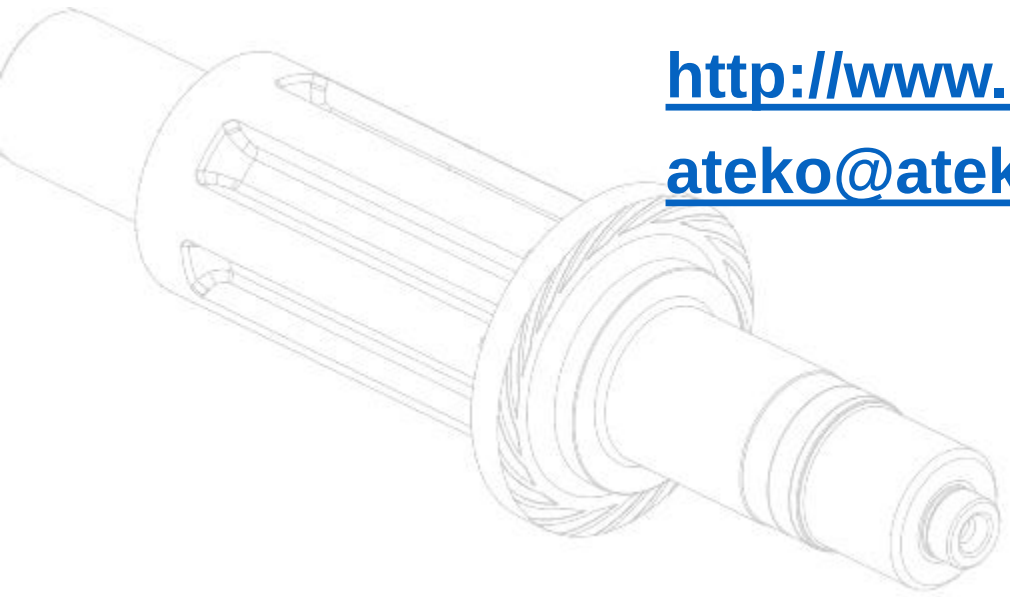




S-ALLEGRO Experimental Helium Loop

S-ALLEGRO Assembly

Thank you for your attention



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